

# Long-Duration High-Frequency Monitoring of Nutrients and Sediments in an Agricultural Watershed

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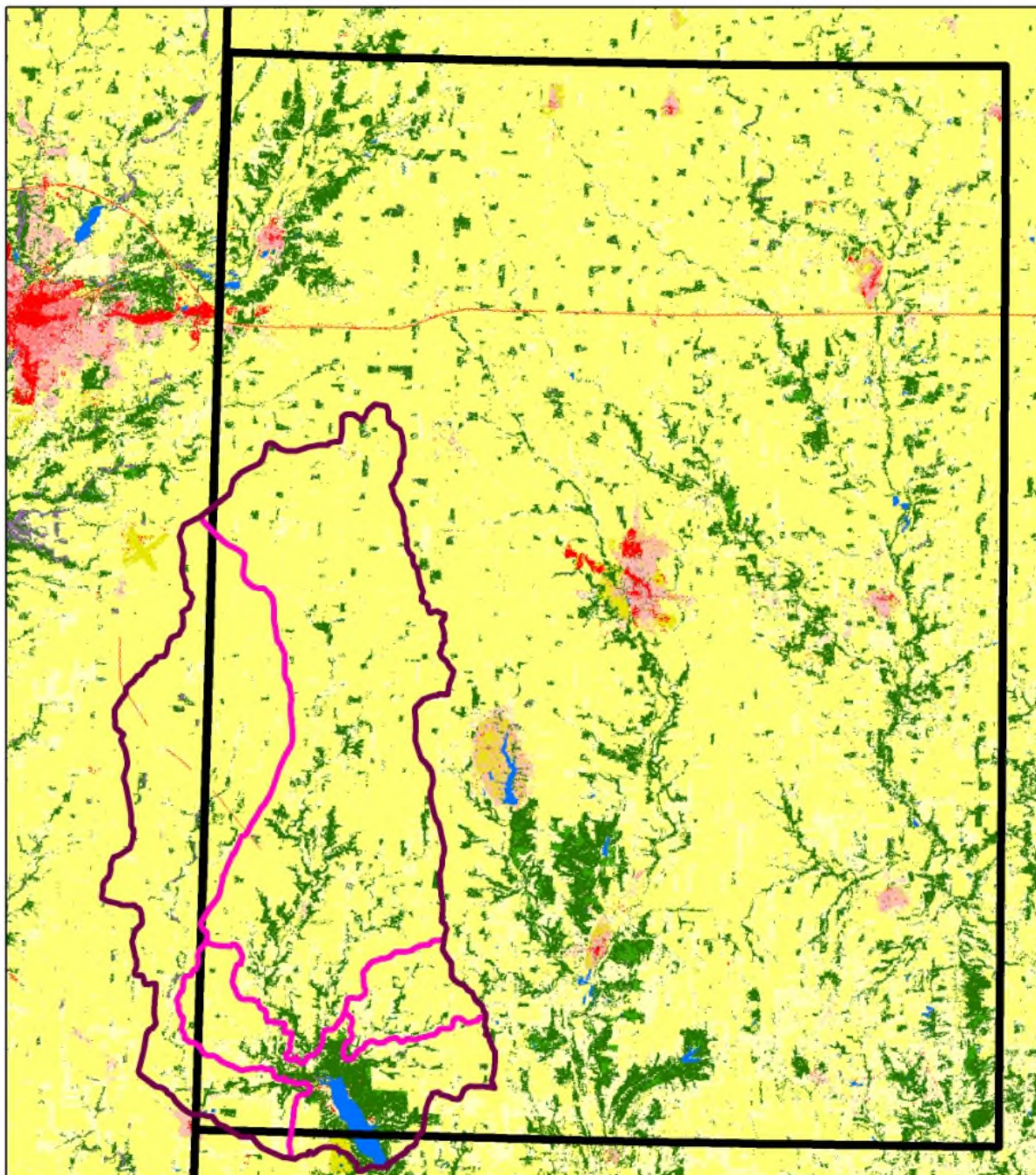
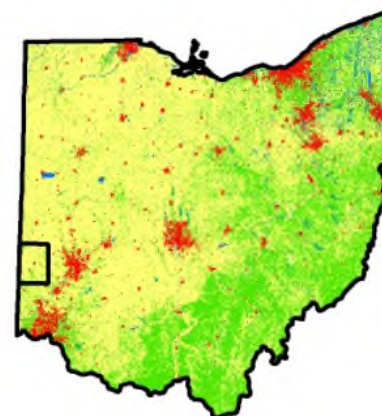
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# Preble County Land Use/Land Cover 2001

## Legend

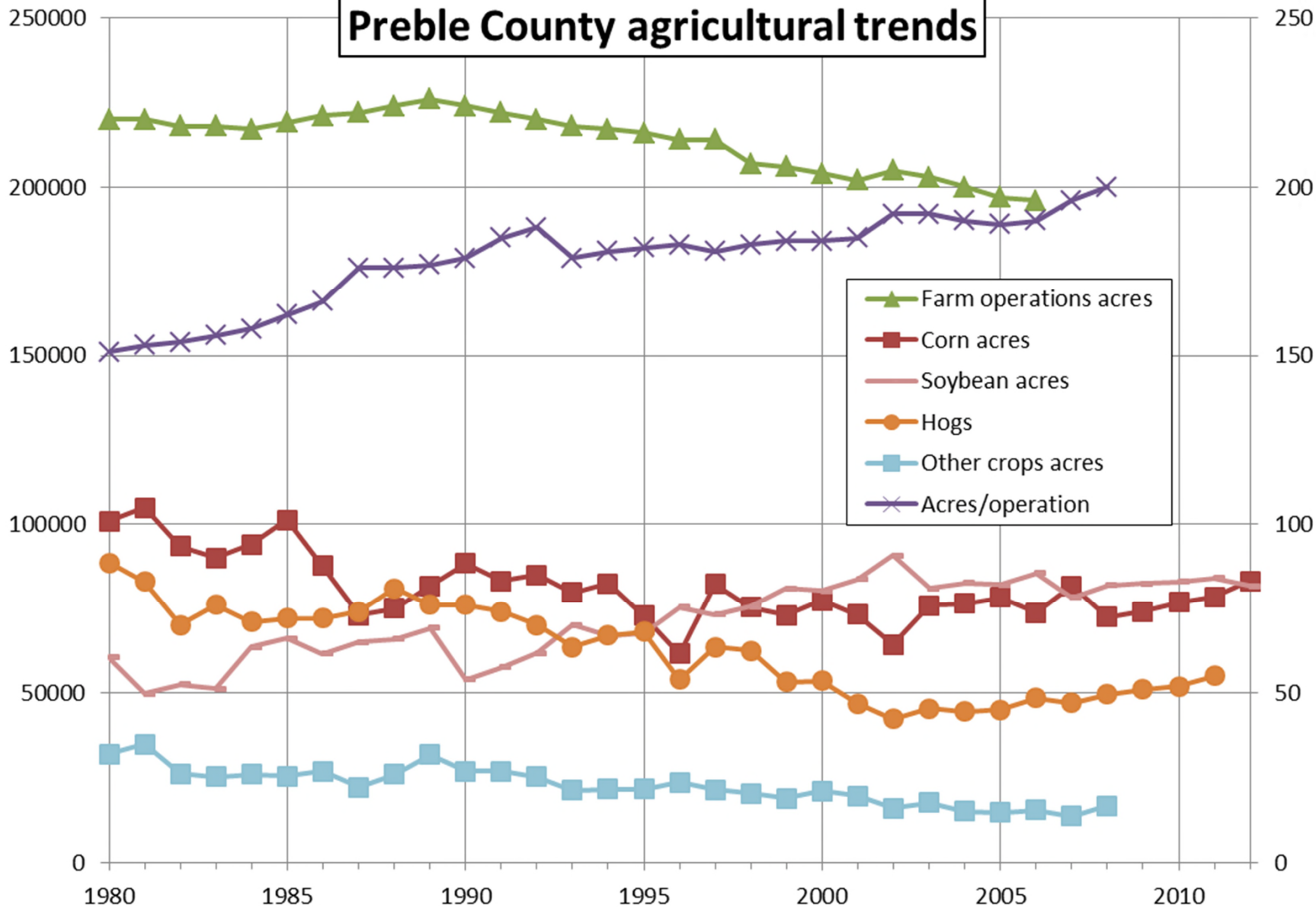
- Water
- Low Density Residential
- High Density Residential
- Commercial/industrial/transportation
- Deciduous forest
- Evergreen forest
- Mixed forest
- Grassland
- Pasture/hay
- Row crops
- Urban recreational/grasses
- Woody wetland
- Emergent herbaceous wetland



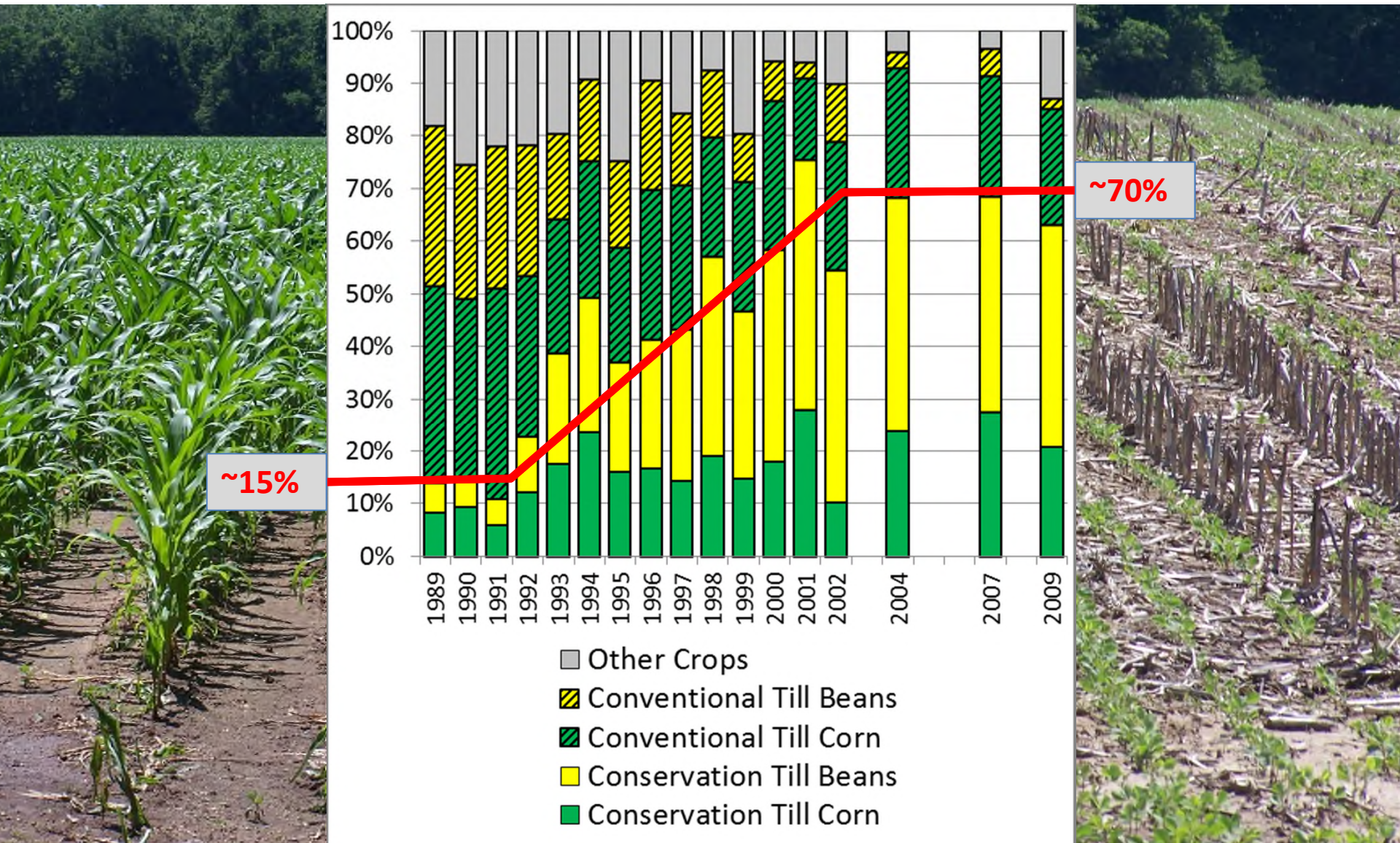
# Preble County agricultural trends

Crop and total acres; Hogs

Acres per operation



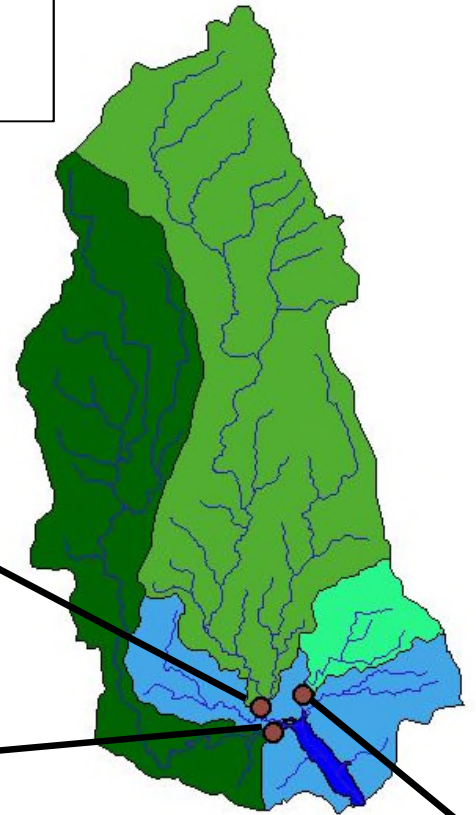
Partly in response to a watershed management initiative, conservation tillage increased in the 1990s.



Monitoring stations were established in 1993-4 on the three largest tributaries to Acton Lake



Each station includes pressure transducer/datalogger for stage, and pumping sampler for water quality.

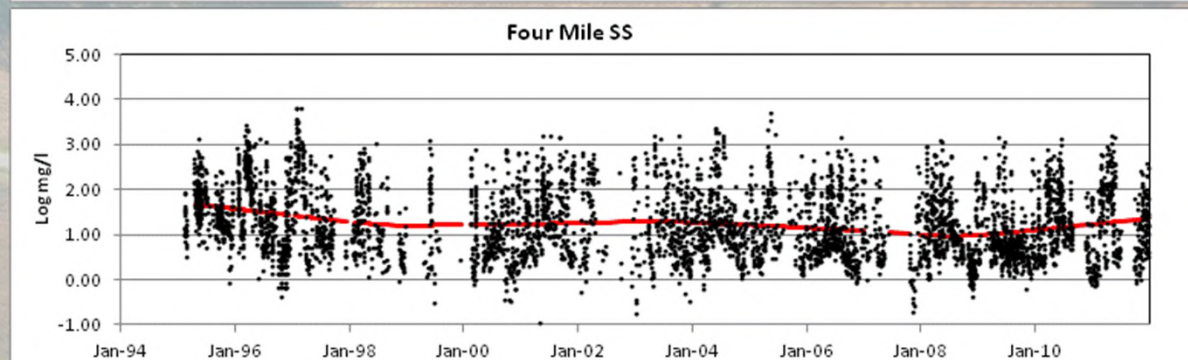
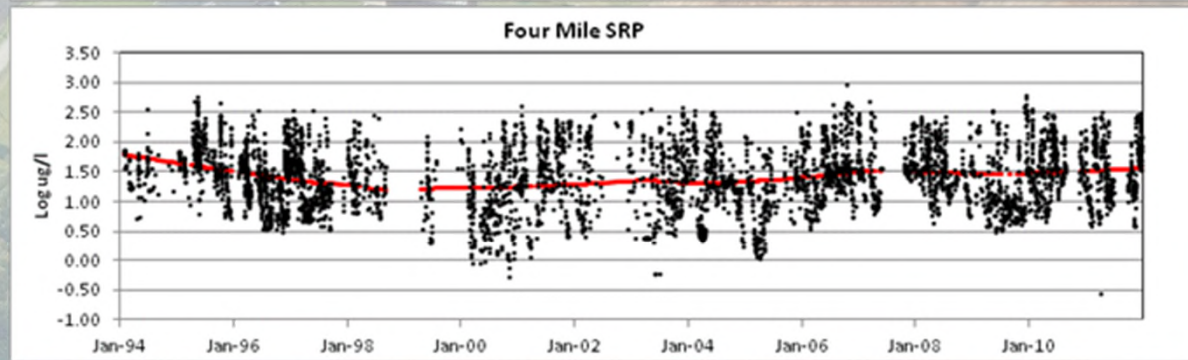
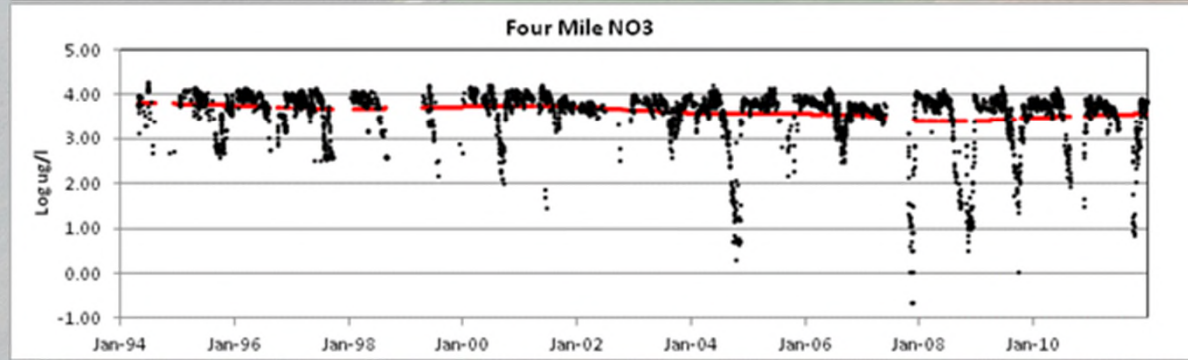
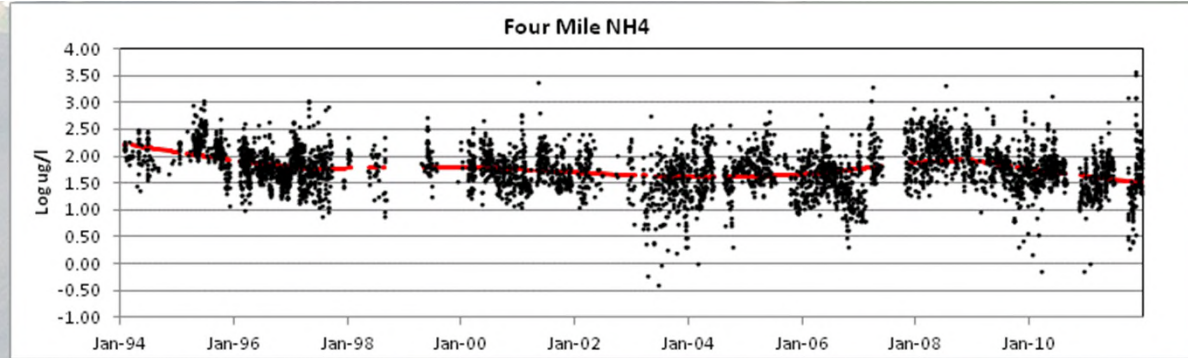


# Monitoring program

- Stage is recorded at 10-minute intervals
- Pumping sampler takes samples at 8-hour intervals.
- Samples are analyzed for  $\text{NH}_4$ ,  $\text{NO}_3$ , Soluble reactive phosphorus (SRP), and suspended sediment (SS)
- All samples collected during storm flow events are analyzed, providing high-resolution record of storm flow concentrations
- At times of base flow typically 3-7 samples per week are analyzed.
- Generally about 300 samples per year are analyzed (no samples at times of zero flow).

# Measured concentrations at Four Mile Creek

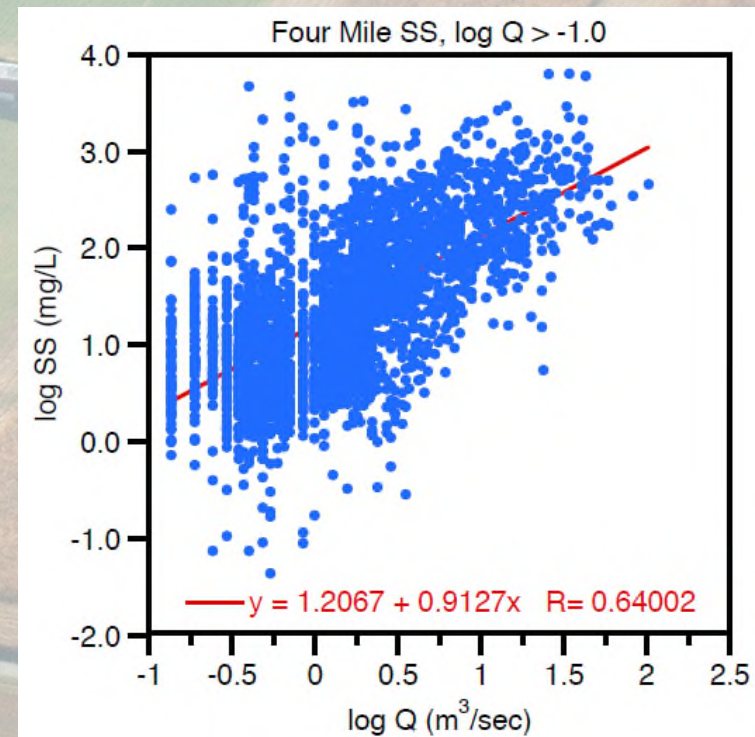
- Data are noisy; concentrations typically vary through 3-4 orders of magnitude.
- Seasonal and longer-term trends are suggested by LOWESS pots



# Flow-proportionate interpolation

We interpolate hourly concentrations of  $\text{NH}_4$ ,  $\text{NO}_3$ , SRP, and SS in order to calculate monthly flow-weighted mean concentrations for trend analysis.

$\text{NH}_4$ , SRP, and SS all display strong effects of flow on concentration. For these parameters, flow-proportionate interpolation is used to estimate concentrations between measured points.



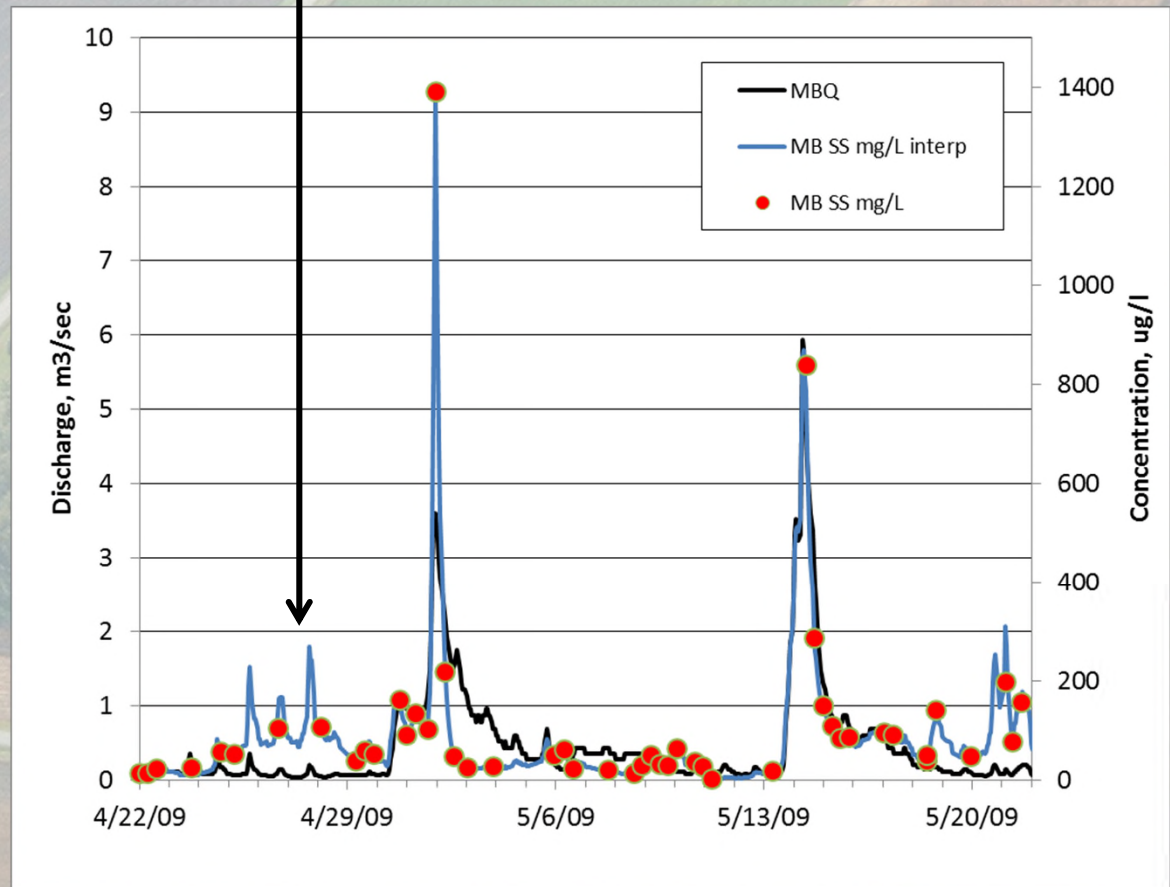
# Flow-proportionate interpolation

The intercept of the log concentration-log Q relation is calculated for each measured point, using the slope of the global log C-log Q relationship.

Intercepts are linearly interpolated between measured points, and concentrations estimated based on the global slope.

Simple interpolation is used for  $\text{NO}_3$ , which does not exhibit consistent variations with Q.

The method estimates effects of flow variations on unmeasured concentrations.



Analyses of data for 1994-2206 indicated strong downward trends in flow-adjusted  $\text{NH}_4$ , SRP, and SS for some streams, but little change in  $\text{NO}_3$ .

The trends are consistent with observed changes in farm operations:

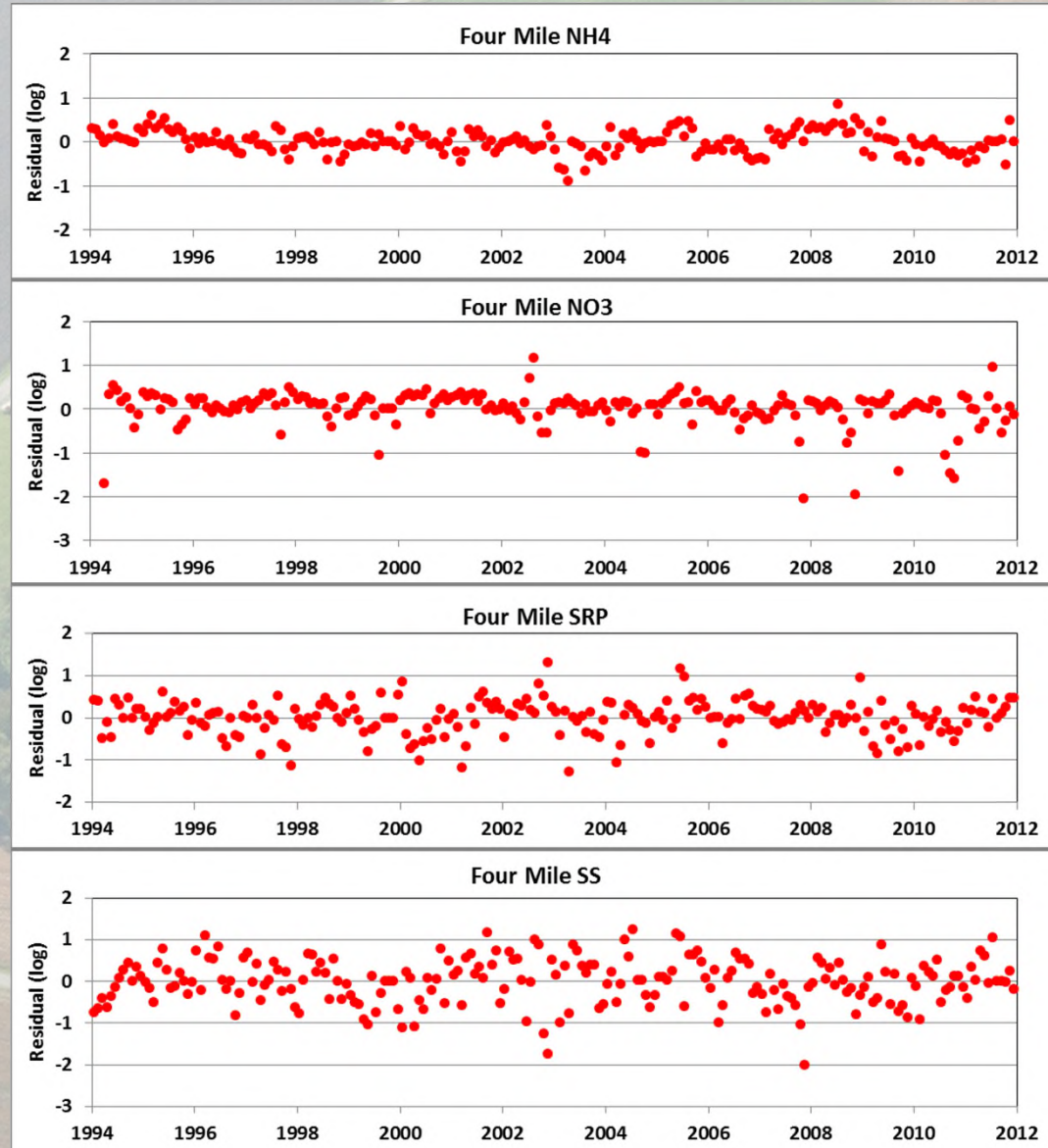
- Increased use of conservation tillage
- More intensive nutrient management
- Indoor hog feeding operations and more intensive manure management

Stream	Parameter	P-value	Change in concentration %/year
Four Mile Creek	$\text{NH}_4$	<.0001	-8.08
	$\text{NO}_3$	0.7756	-0.63
	SRP	0.0118	-4.21
	SS	<.0001	-6.44
Little Four Mile Creek	$\text{NH}_4$	0.0027	-8.86
	$\text{NO}_3$	0.3344	-2.19
	SRP	0.1870	-6.46
	SS	0.0071	-8.12
Marshall's Branch	$\text{NH}_4$	0.0117	-7.91
	$\text{NO}_3$	0.0001	-11.57
	SRP	<.0001	-12.31
	SS	0.9127	-0.32

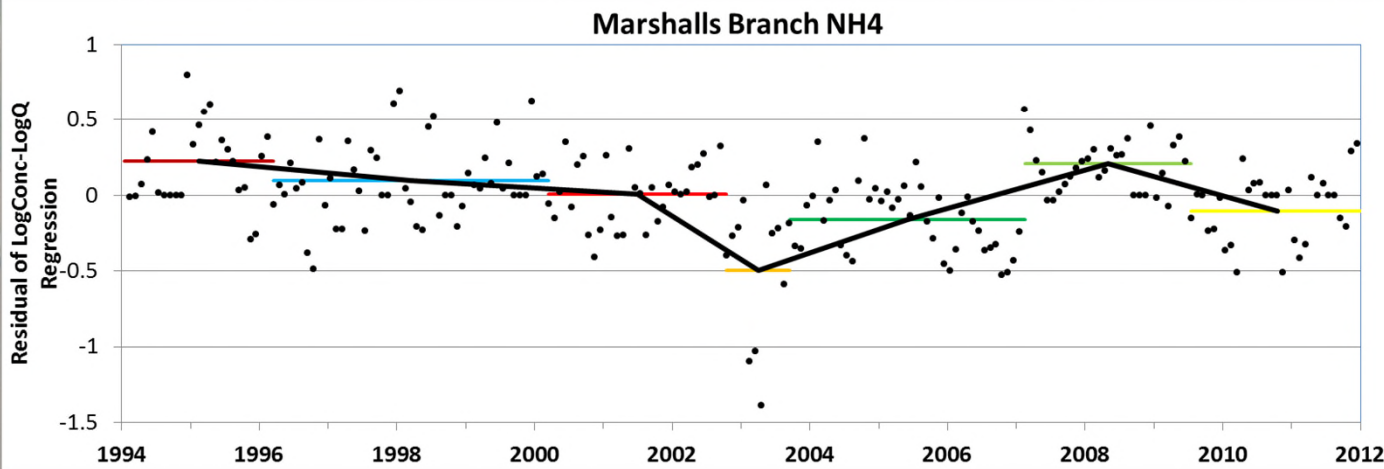
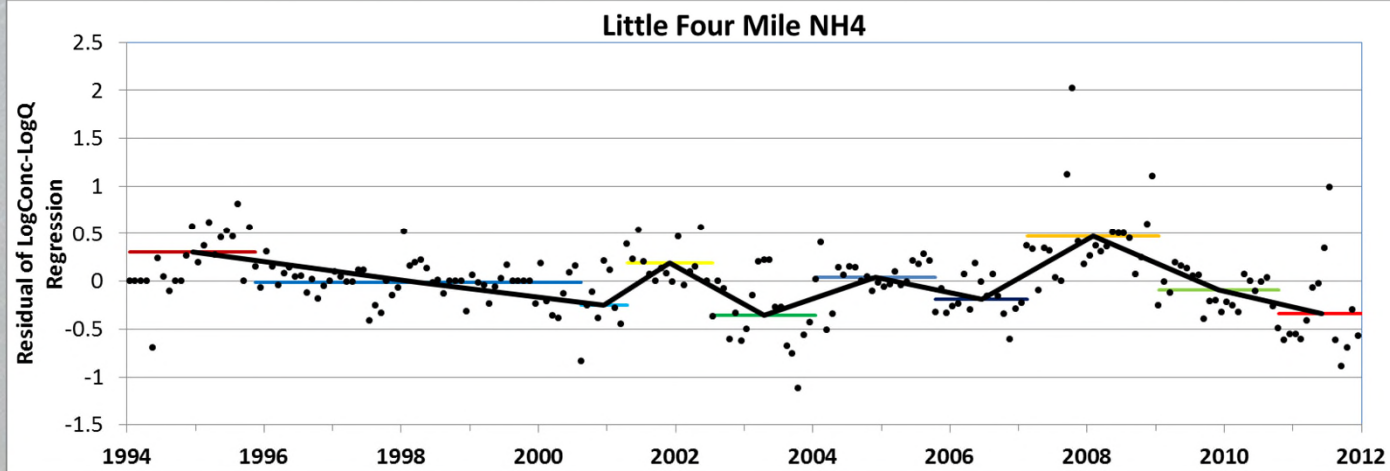
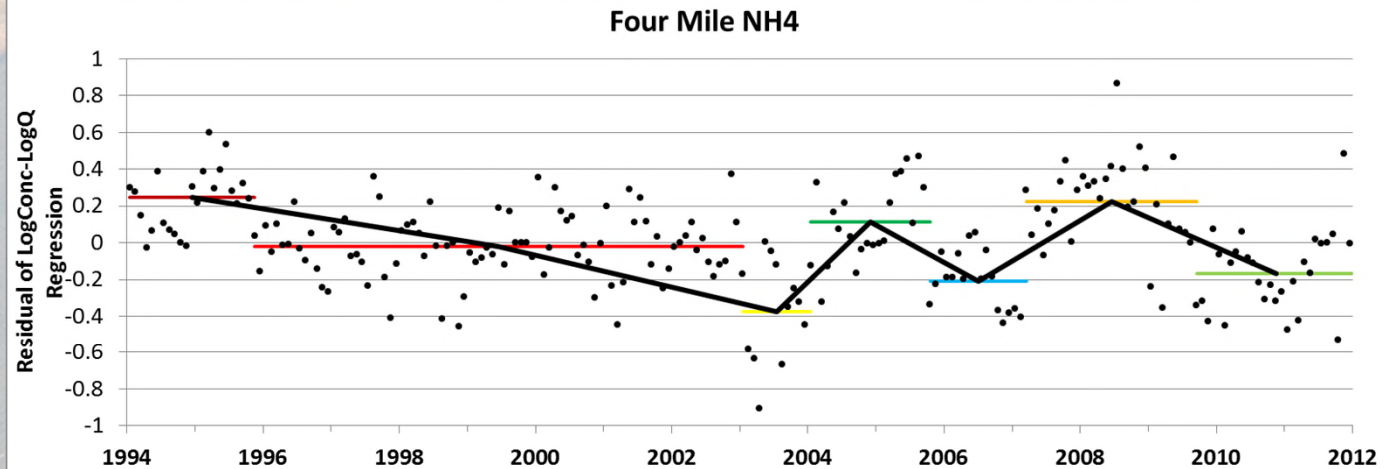
# Decision-tree/change point analyses can identify changes in trends within the record.

Graphs at right show residuals in the mean monthly log concentration–log flow relationship.

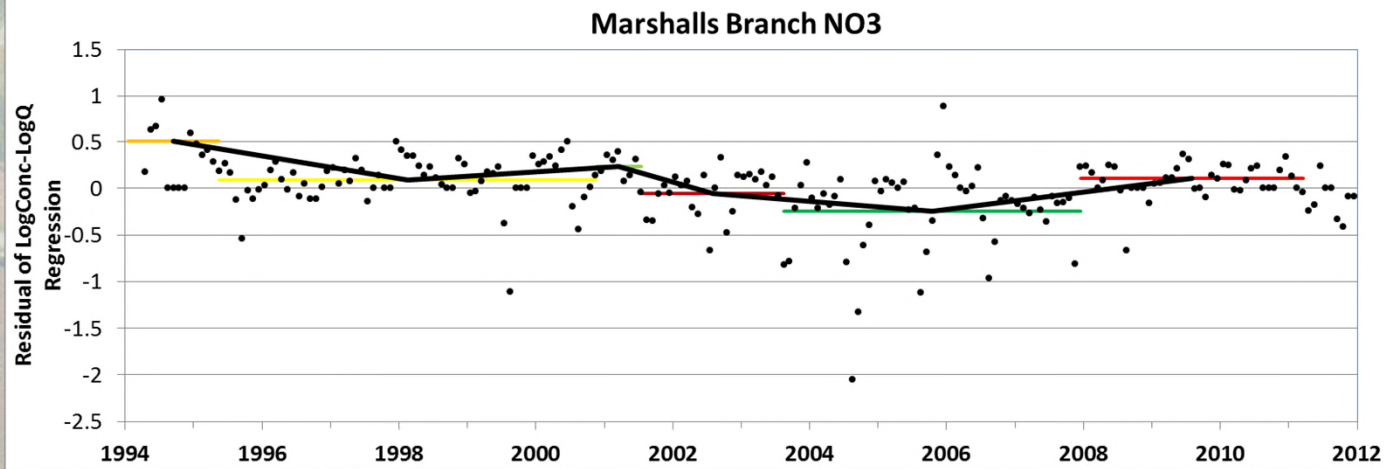
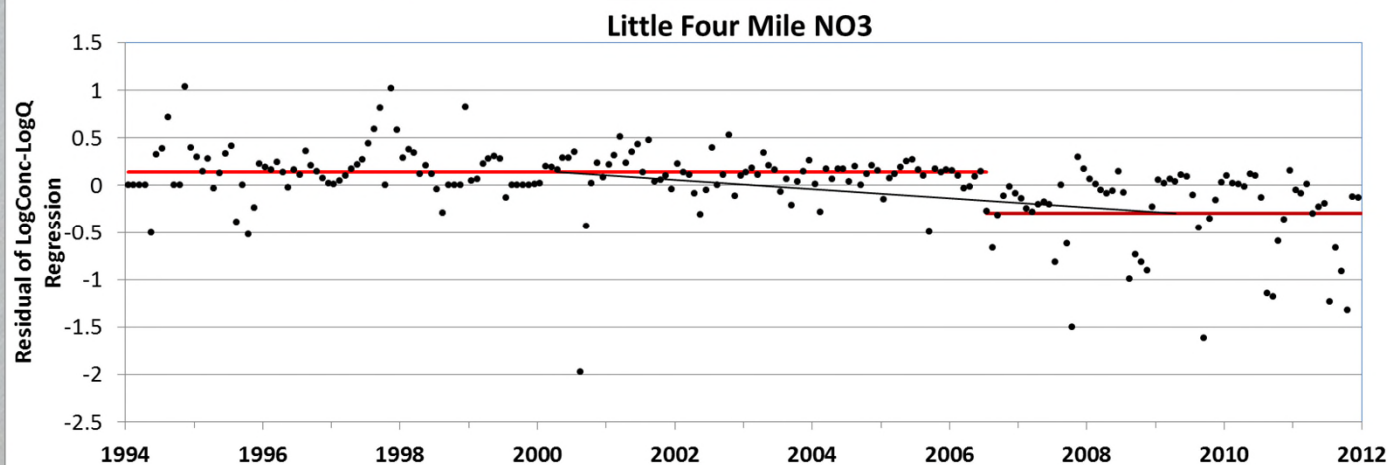
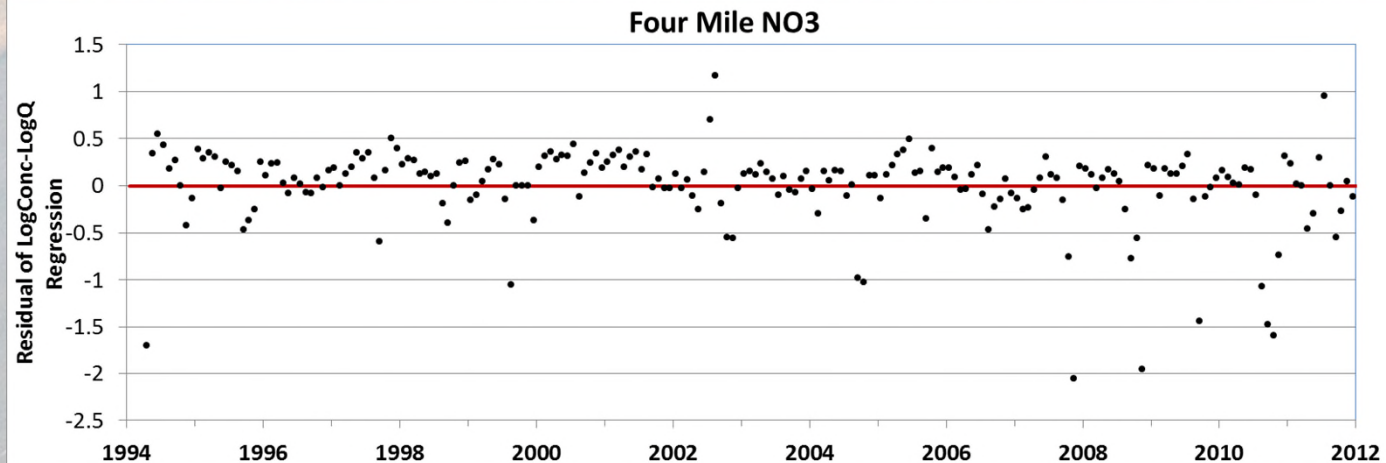
We used decision tree/change point analyses to identify locations in the record where the relation between flow and concentration changes significantly.



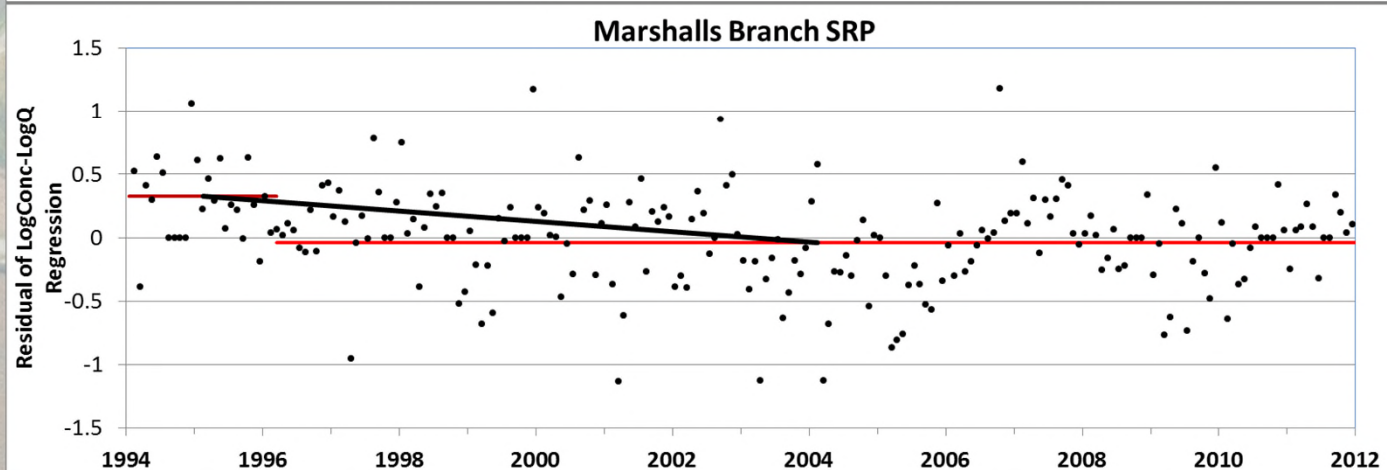
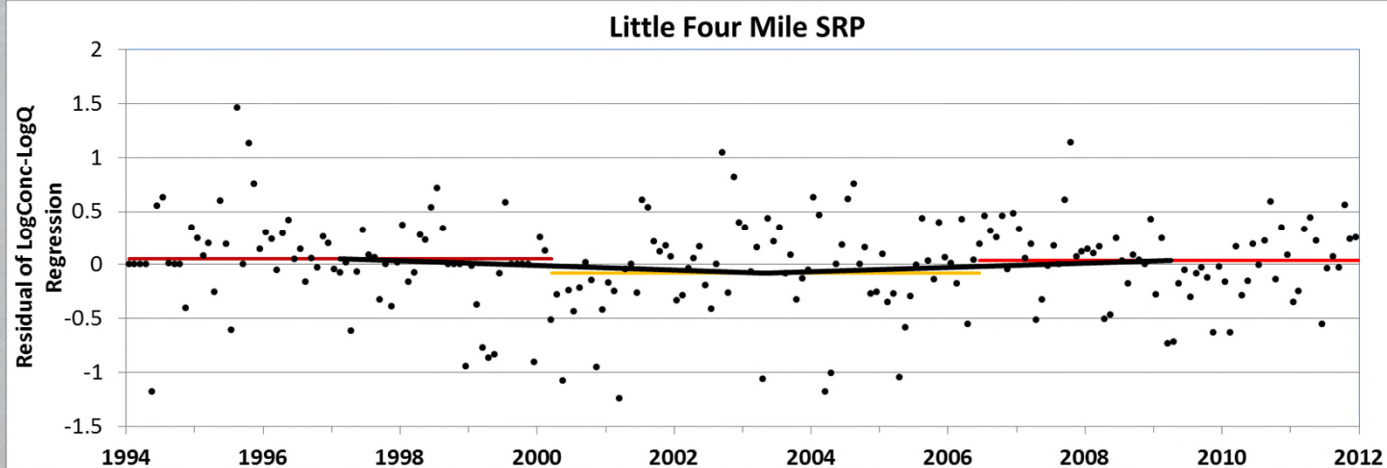
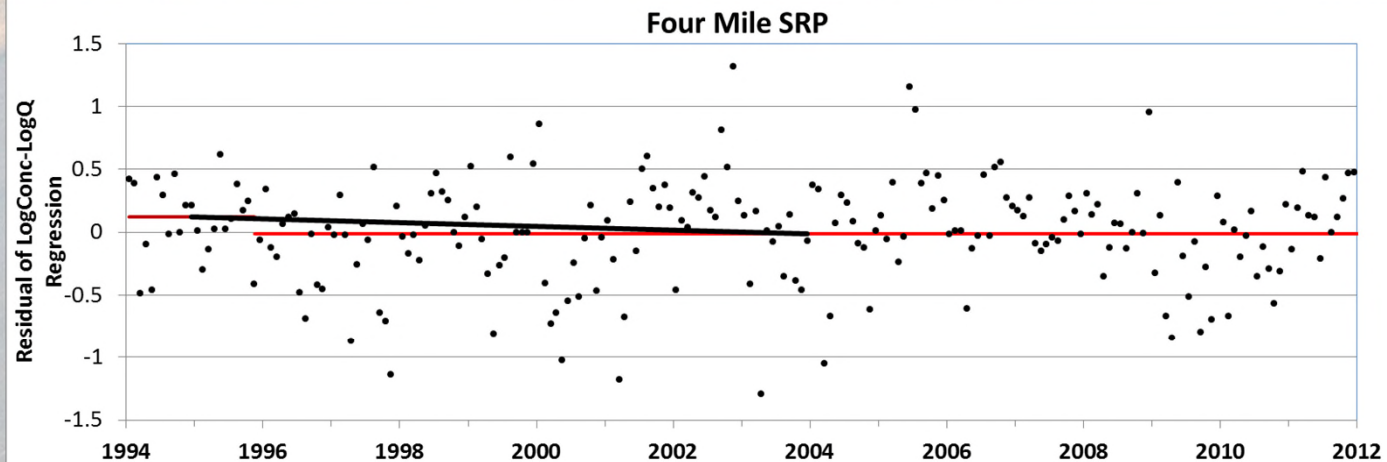
The strong decline in NH<sub>4</sub> observed in 1994-2006 data appears to have ceased or reversed.



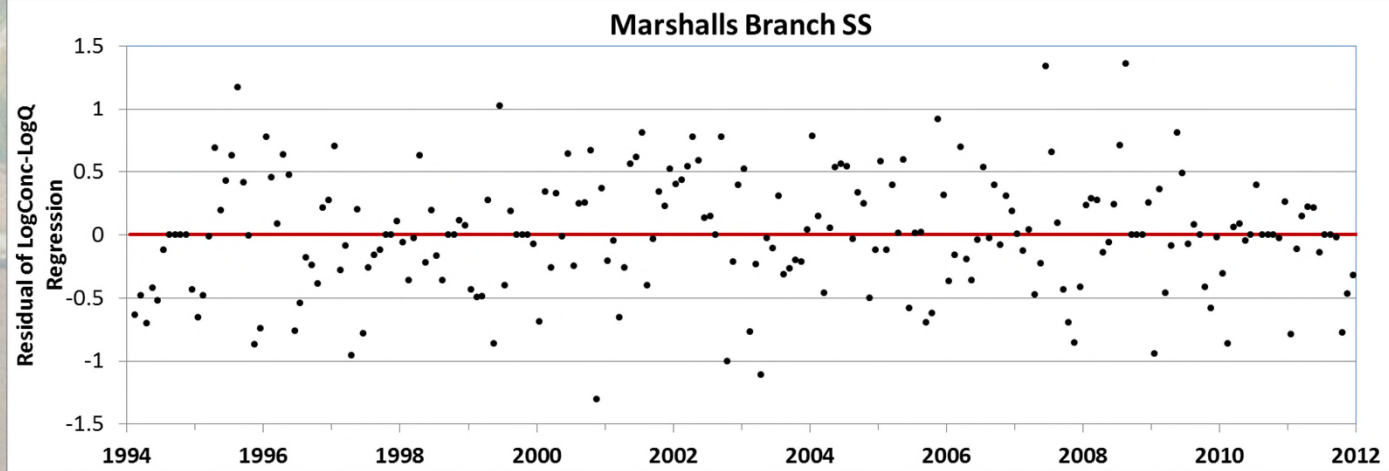
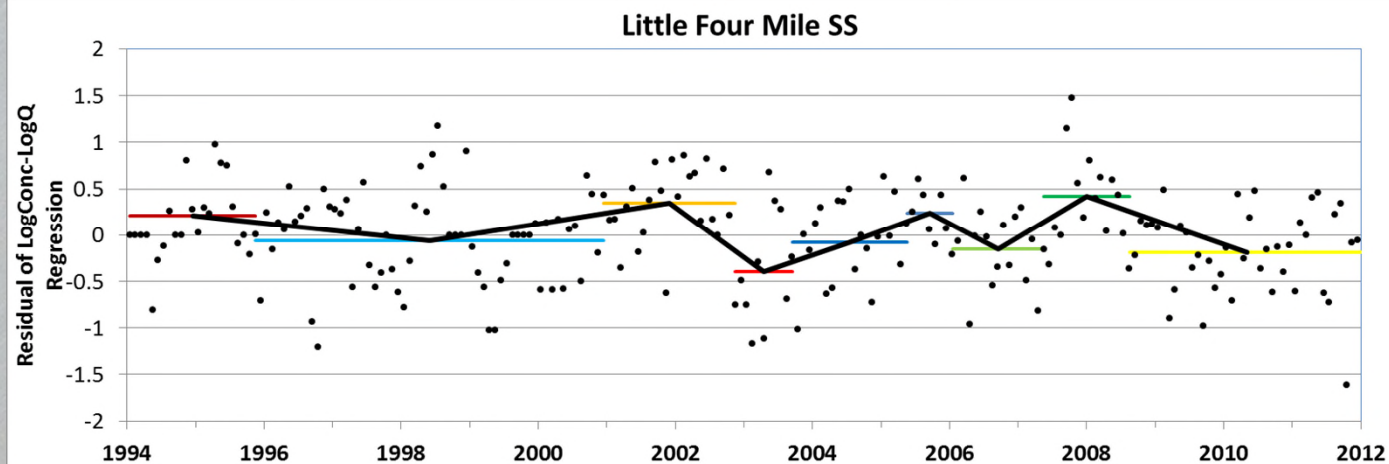
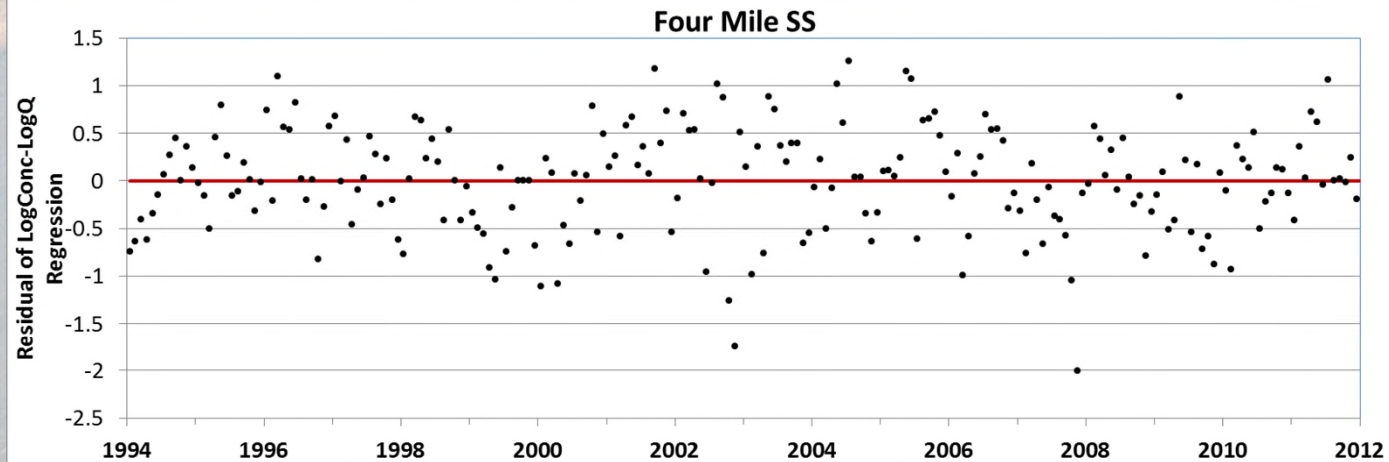
NO<sub>3</sub>, which declined only slightly or was unchanged in 1994-2006, may be beginning to decline significantly.



The decline in  
SRP observed  
in the 1994-  
2006 data  
appears to  
have ended.



The decline in  
SS observed in  
the 1994-2006  
data has  
disappeared.



# Summary/conclusions

- High-resolution, flow-dependent sampling programs allow detection of subtle changes in water quality.
- Improved farm management practices appear to have had a significant positive impact on water quality, especially in the 1990s.
- Declines in concentrations of  $\text{NH}_4$ , SRP, and SS observed for 1994-2006 appear to have ceased, while  $\text{NO}_3$  has declined more recently.
- Improvements in water quality in the 1990s may be overshadowed by other trends, such as P-saturation in soils and increased stream channel erosion.

# Thanks!

- Mike Hughes, Miami University
- National Science Foundation
- US Department of Agriculture
- Preble Soil & Water Conservation District
- Miami Resource Conservation and Development Council
- Miami University
- *Many* dedicated students